TP76 Micro-CT Scatter Evaluation

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1. Objectives

Quantitative accuracy of the Micro-CT Test bed (MCT-TB) system is compromised by errors introduced by radiation scattered in the object of interest. The objective of this test plan is to quantitatively estimate the impact of scatter on the reconstructed object and use the measurements to design a scatter correction algorithm for the system.

2. Summary of Approach

Data will be acquired at LLNL on the MCT-TB system at different spectral energies. The data acquired will include references that are housed in the lower tray of the Micro-CT carousel and known samples located in the upper tray of the Micro-CT carousel. The scans shall be run in both the one-slit (top collimator plate removed) and two-slit collimator configurations.

3. Materials and Specimens:

a) Micro-CT Carousel [Smith1]
b) Collimating slits
c) Test Materials (see Table 1)

A total of 4 specimens will be scanned in each spectral configuration and each slit configuration. All specimens are simple solid right-circular cylindrical objects.

4. X-ray Systems:

a) MCT-TB System

Name	Reference	LEDP ID	Temp ID	Dia (cm)	Length (cm)
Specimen 1	Graphite	LL-GRA-00-02	A15	2.535	5.152
Specimen 2	Graphite	LL-GRA-00-03	A6	5.07	2.535
Specimen 3	Silicon[1]	LL-SIL-00-01	A5	1.2675	3.1688
Specimen 4	Silicon[1]	LL-SIL-00-02	A9	2.535	2.535

[1] Operator will wear Nitrile Gloves while handling the Silicon sample

Table 1. *Materials to be used for data acquisition.*

5. System Spectra

The CT data will be acquired at two separate x-ray spectra for the MCT-TB. Figure 2 defines the spectral, filtering and which system will be used for each spectrum. Both spectra are to be taken with the small focal spot.

Name	kVp	Filter	Detector	mA	Time
Spectrum 1A	100	2.0 mm Al	Perkin Elmer	2.2	0.8 int
Spectrum 2A	160	2.0 mm Al & 2 mm Cu	Perkin Elmer	3.5	1.2 int

Table 2. kVp and tube-head filtering requirements for each spectrum.

6. CT Technique Parameters

For data acquired at each spectrum and for each system, a technique sheet will be prepared that outlines the CT technique parameters. The parameter spreadsheet is located in Appendix A and the Excel workbook can be found under:

W:\Documents\Documents\Testplans\TP75_MCT_TB_Multi_Energy_Decomposition_Plan\Spreadsheets\Technique_Template.xlsx

Where:

W: Is the Windows® drive letter associated with the LEDP Working Directory

All Micro-CT technique sheets will be placed on the LEDP server. All directory paths and filenames should *NOT* contain any spaces. Use an underscore "_" symbol for a space. The data shall be filed as follows:
W:*\Working\TP76_MCT_TB_Scatter_Evaluation\LLNL\None\Techniques\Spectra_****Num***

Where:

W: - Is the Windows® drive letter associated with the LEDP Working Directory

Num - is the spectrum number 1A or 2A

For the spectra listed in section 5, tube current and detector integration times may need to be determined. The procedure below outlines the process to acquire tube current and detector integration times for each system at each defined spectrum.

Spectra 1A and 2A:

- The tube current and integration times have been determined.

7. System Alignment

The Micro-CT system must be aligned before any data acquisition. If the system is not aligned or there is reason to believe it may be out of alignment, the system will be aligned using the fine alignment SOP [Smith2].

8. Acquiring Calibration Files

Detector panel calibration files will be acquired once a week. The calibration files (Dark, Light and Mid) will be acquired at each spectrum using the corresponding spectrum filtration and integration times. The calibration files will be used to calibrate the panel for all data acquisitions until a new set is acquired. To acquire calibration files follow the procedure outlined below

8.1 Select the proper kVp, filtration and Integration times for Spectrum 1A.
8.2 Remove the copper strip from the detector and remove the Slit Collimator from the field of view
8.3 Turn on the x-rays and wait 2 minutes
8.4 Run the calibration mode from the data acquisition software and acquire an image. Use 16 frame averages.
8.5 Adjust the tube current until the image contains a maximum of 45000 +/- 3000 counts. This is the Light calibration file.
8.6 Adjust the tube current to 60% of the Light field current. Acquire another image using 16 frame averages. This is the Mid calibration file.
8.7 Turn off x-rays and wait 2 minutes.
8.8 Acquire another image with x-rays off with 16 frame average. This is the Dark calibration filed.
8.9 Save the calibration files with unique filenames and inside the xtech directory
8.10 Repeat steps 8.1 thru 8.9 for the other spectra

9. MCT-TB Procedure

The MCT-TB procedure uses one set of spectra.

Spectral Set 1: Spectrum 1A and Spectrum 2A. These spectra should be run in that order, low energy before high energy.

Spectral Set 1 must be run in a single day, and with minimal delay between the separate spectra. Do not touch or move the specimen between spectra or between spectral sets.

The MCT-TB procedure uses Spectra 2A and 1A. All CT parameters shall be setup before data acquisition using the corresponding CT Technique Sheet (see section 6) and CT data from the two spectra needs to be registered. The scanning procedure is summarized in IDD-MCT-SOP-03. All data must be collected in RAW mode. This feature must be manually set for the MCT-TB system.

10. Photographs

Photographs of each test sample will be acquired. All Micro-CT photographs will be placed on the LEDP server. All directory paths and filenames should *NOT* contain any spaces. Use an underscore "_" symbol for a space. The data shall be filed as follows:

W:\Working\TP76_MCT_TB_Scatter_Evaluation\LLNL\None\Photos\Sample_Num

Where:

W: - Is the Windows® drive letter associated with the LEDP Working Directory

A photograph of the system showing the x-ray source, staging, carousel and detector will be acquired. The data shall be filed as follows:

W:\Working\TP76_MCT_TB_Scatter_Evaluation\LLNL\None\Photos

Where:

W: - Is the Windows® drive letter associated with the LEDP Working Directory

11. Data Transfer

All Micro-CT data will be placed on the LEDP server. All directory paths and filenames should *NOT* contain any spaces. Use an underscore "_" symbol for a space. The data shall be filed as follows:

W:\Working\TP76_MCT_TB_Scatter_Evaluatiom\LLNL\None\YYMMDD_SampNum_SPNum_Slit

Where:

W: - Is the Windows® drive letter associated with the LEDP Working Directory

YYMMDD - is the acquisition date

SPNum - is the spectrum number 1A or 2A.

SampNum – is the specimen number 1, 2, 3, and 4.

Slit – is the number of slits, 1 or 2.

12. References

Smith1 Smith, Jerel A. and Daniel Schneberk, Jeffrey Kallman, Harry Martz, "Documentation of the LLNL and Tyndall MicroComputed Tomography System", Lawrence Livermore National Laboratory, 17 December, 2009

Smith2 Fine alignment SOP

Appendix A – Technique Sheet Template

Title	
System Information	
Data Acquistion Date	
System	
Archive Directory	
Source	
X-ray Source	Yxlon 450kV D09
Effective Spot Size (mm)	Small 0.4
Energy (kV)	
Tube Curren t (mA)	
Unsharpness (mm)	
Filter (Type/Thickness mm)	
Detector	
Detector Type	Amorphous Silicon Thales/Perkin Elmer
Source-Detector-Distance (SDD) (mm)	
Source-Object-Distance (SOD) (mm)	
Object-Detector-Distance (ODD) (mm)	
X-Offset (Pixels)	
X-Size (Pixels)	
Y-Offset (Pixels)	
Y-Size (Pixels)	
Magnification	
Frame Average(s)	4
Integration Knob-Thales Only	
Integration Time per Projection(sec)	
Raw Pixel Size (mm)	0.127/0.200
Global Resampling	1.5 / 1.0
Effective Pixel size at Detector (mm)	0.1905/ 0.200
Effective Pixel size at Object (mm)	
CT Parameters	
Numbers of Views	721
Number of Angles	
Delta Angle (Degrees)	0.5
Estimated PxCenter (Pixel)	
Estimated PzCenter (Pixel)	